Fluoride Domestic Water and Periodontal Disease

A. L. RUSSELL, D.D.S.

This is another of the many factual findings that health people must have at their command if they are to answer with convincing scientific evidence the misinformation spread by fluoridation's opponents. The last paper of the "Newer Developments in Water Fluoridation" symposium will follow next month.

Other reports in this series describe some basic epidemiologic characteristics of periodontal disease in urban [1] and in rural [2] populations and explore an unknown social factor, indicated by levels of education, which is associated with the severity of disease once present.[3] This paper summarizes the evidence bearing upon the relation of periodontal disease to use of a fluoride-bearing domestic water, including all pertinent data collected by us through the summer of 1956. The data are based on examinations of nearly 20,000 persons of both sexes, ranging in age from seven to 78 years.

Though many opinions have been expressed in this area, very little epidemiologic evidence has been offered. Brown, Kohli, MacDonald, and McLaren surveyed children aged six to 14 years in three Canadian cities, using the P-M-A index of gingivitis. The domestic waters in these cities carried none, 1.0, and 1.3 ppm of fluorides (F), respectively. The least gingivitis was found in the community with 1.0 ppm of fluoride; rather more gingivitis was found in the fluoride-free community; and substantially more in the community with 1.3 ppm of fluoride.[4] In 10-year summaries of the fluoridation study at Newburgh, N. Y., Ast and his co-workers have reported that there was slightly but significantly more gingivitis in children of Kingston, the control city, than in children of Newburgh who had used a fluoridated water for from seven to 10 years.[5, 6] This examination was carried out by the author and its findings will be presented here in greater detail.

Method

If any relation between the use of a fluoride domestic water and health or disease in periodontal tissues exists in fact, it should readily be demonstrable by the methods which have established the inhibitory effect of fluoride waters upon dental caries. The most common method has contrasted a fluoride-free population with others using domestic waters with varying fluoride concentrations. Additional evidence has resulted from contrasts of the status of natives in a fluoride community with the status of migrant persons who have used the same water for a shorter period of time. Both methods are applied to periodontal disease in the present report.

The examination and scoring methods previously described [7] were used throughout the series. All of the examinations were performed by the author, or by observers directly calibrated with him.

Fluoride Versus Nonfluoride Populations

Three studies have been carried out by us which contrast the periodontal status of residents of fluoride and non-

Table 1—Relative Prevalence and Severity of Gingival Disease in Children of Newburgh and of Kingston, N. Y., (Mar. 1955)

Age Group	Mean Age, Years	No. Examined	Per cent Negative	Mean Score
Newburgh (1.0 ppm F Since 1945)				
7–9	8.9	238	91.6	0.02
10–12	11.3	352	92.0	0.03
13–14	13.6	29	96.6	0.03
All ages	10.5	619	92.1	0.02
Kingston (Fluoride-Free)				
7–9	9.0	246	84.1	0.03
10–12	11.3	328	84.8	0.04
13–14	13.6	18	88.9	0.08
All ages	10.4	592	84.6	0.04

fluoride communities. They are presented here in order of the ages of the persons examined and of the concentration of fluoride in the three domestic waters.

Newburgh-Kingston — The domestic water of Newburgh, N. Y., was fluoridated early in the summer of 1945 in a study project conducted by Ast and his co-workers, under the auspices of the State of New York Department of Health. The water in nearby Kingston was maintained fluoride-free as a control. Through the courtesy of Ast and his group about 600 children aged seven to 14 years were examined for periodontal disease in each of the cities in March of 1955. The results of this examination are summarized in Table 1.

The proportions of children free from overt signs of disease were higher throughout the age range in children of Newburgh, the fluoride city, than in children of Kingston, the control. For the whole groups the difference between the proportions is significant.* Mean population scores, which reflect both the prevalence and severity of disease, were uniformly higher in Kingston than in Newburgh; for the whole groups the difference is on the borderline of significance at the $P = 0.05$ level. This difference is due wholly to the higher prevalence of disease in Kingston. When present, disease was of about equal severity in the two communities. One child with marginal periodontitis which had progressed to the stage of frank pocket formation was found in each city.

Colorado Springs-Boulder — Native adults of Colorado Springs, Colo. (with a domestic water carrying about 2.5 ppm of fluoride) and of Boulder, Colo. (with a domestic water essentially fluoride-free) were examined in the fall of 1950. Their dental caries status has been reported previously.[8] Data were

* When not stated, the level of significance used is the $P = 0.01$ level.

Dr. Russell is chief, Epidemiology and Biometry Branch, National Institute of Dental Research, National Institutes of Health, Public Health Service, U. S. Department of Health, Education, and Welfare, Bethesda, Md.

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Table 2—Relative Prevalence and Severity of Periodontal Disease in Native Residents of Boulder and of Colorado Springs, Colo. (1950)

Age Group	Mean Age	Number Examined	Per cent Negative	Per cent with Pockets	Mean Score	Additional Per cent Edentulous *
			Colorado Springs (2.5 ppm F)			
20–24	22.7	72	58.3	4.2	0.33	0.0
25–29	27.5	101	55.4	4.0	0.39	0.0
30–34	32.2	82	54.9	15.9	0.66	0.0
35–44	39.6	124	46.0	23.4	0.91	4.6
All ages	31.6	379	52.8	12.9	0.60	1.6
			Boulder (Fluoride-Free)			
20–24	22.4	51	52.9	7.8	0.47	0.0
25–29	27.1	41	29.3	19.5	0.81	0.0
30–34	32.0	27	44.4	22.2	0.66	6.9
35–44	39.3	25	16.0	56.0	1.54	26.5
All ages	28.5	144	38.2	22.2	0.79	7.1

* Not included in the totals listed under "numbers examined."

limited to persons aged 20–44 years because the fluoride content of Boulder water prior to 1906 could not be established. Periodontal findings for these people are summarized in Table 2.

Periodontal disease was more prevalent in lifetime residents of Boulder, using a fluoride-free water, than in lifetime residents of Colorado Springs, who had always used a water containing about 2.5 ppm of fluoride. There were significantly fewer Boulder natives free of disease and significantly more Boulder natives with advanced disease. These differences are reflected in the relative scores. Once initiated, disease was equally severe in the two communities; mean scores for the 89 persons in Boulder and for the 179 persons in Colorado Springs who exhibited signs of disease were identical at 1.28. As in the Newburgh-Kingston study, the observed differences were wholly due to the higher prevalence of disease in the community using the fluoride-free water.

These findings are based upon direct observation by the examiner. While weaker as evidence, indirect findings based upon histories supplied by examinees were consistent with the direct findings. On the basis of these histories, slightly more teeth per person had been extracted because of periodontal disease in Boulder than in Colorado Springs.[8] Among persons wholly edentulous three in Colorado Springs (0.8 per cent of the population examined) and four in Boulder (2.8 per cent of the population examined) testified that periodontal disease had been the major reason why their teeth had been extracted.

Bartlett-Cameron—Smaller groups of older adults were examined in 1953 in Bartlett and in Cameron, Tex. Until a defluoridation plant was installed a short time before this examination Bartlett's domestic water had contained about 8.0 ppm of fluoride. The fluoride content of Cameron's water was about 0.4 ppm.

The objective in 1953 was the reexamination of a group of people who had received detailed physical examinations 10 years previously. Of these

original subjects, 76 were reexamined in Bartlett and 80 in Cameron. Very few were natives of either city. The average length of residence had been 37 years in Bartlett, and 38 years in Cameron. No differences in periodontal disease, on the basis of clinical and x-ray examination, had been seen in these people in 1943.[9] In 1953 there were no significant differences between the groups, as estimated by the P-M-A index and by the degree of alveolar bone resorption disclosed by x-ray.[10] The relative status of these two groups, as scored by the periodontal index, is shown in Table 3. Because of the small numbers of dentulous persons and the wide age range (25 through 78 years) findings are shown for the total groups.

Nearly all the persons seen in both cities exhibited some sign of disease. Differences seen were small and favored the Bartlett group, which had used the water containing about 8.0 ppm of fluoride. Unlike the two contrasts previously cited there was a difference in severity of disease; periodontal destruction was appreciably more advanced in the low-fluoride group. There were about twice as many persons in Cameron as in Bartlett (11, or 13.8 per cent of the group in Cameron against 5, or 6.6 per cent of the group in Bartlett) in whom tissue destruction was so advanced that full-mouth extractions were indicated.

Indirect evidence was opposite in direction. About twice as many of the edentulous persons in Bartlett as in Cameron (21, or 26.6 per cent of the whole group in Bartlett against 9, or 11.3 per cent of the whole group in Cameron) believed that periodontal disease had been the primary reason for loss of their teeth. If the numbers requiring full-mouth extractions are combined with these, tooth mortality findings differ only by chance between the two groups, and group scores for the remaining persons are about the same. This supports the previous conclusion, based on other methods of estimation, that "the periodontal health of the Bartlett and Cameron subjects was approximately the same." [10]

Summary—In each of these contrasts the more favorable condition of the periodontal tissues was observed in the fluoride community. In the two adult groups indirect evidence was opposite in direction. The three populations included persons aged seven through 78 years. Two of the groups had used a domestic water containing fluorides considered to be excessive in amount—2.5 and 8.0 ppm, respectively. The fluoride water had been consumed for from seven years in children to as long as 44 years in adults. If use of a fluoride domestic water has any adverse effect upon the health of periodontal tissues, it is quite likely that this effect would have been revealed clearly in one or all of these studies. The fact that no ad-

Table 3—Relative Prevalence and Severity of Periodontal Disease in Residents of Bartlett, Tex. (with an Average of 37 Years' Use of a Domestic Water Containing About 8.0 ppm F) and of Cameron, Tex. (with an Average of 38 Years' Use of a Domestic Water Containing About 0.4 ppm F)

City	No. Examined	Mean Age	Per cent Negative	Per cent with Pockets	Mean Score	Additional Per cent Edentulous *
Bartlett	45	54.3	4.4	62.2	1.70	40.8
Cameron	64	53.9	3.1	68.8	2.01	20.0

* Not included in the totals listed under "number examined."

Table 4—Periodontal Scores of Native and Migrant Children in a Series of Communities with Domestic Waters Containing About 1.0 Parts per Million of Fluorides, 1952–1956

Group	Year of Examination	Years F Use- age, Natives	Natives No.	Natives Mean Age	Natives Mean Score	Migrants No.	Migrants Mean Age	Migrants Mean Score	Difference (Native Score Minus Migrant)
Montgomery Co., Md. (A)	1952	0.0	307	8.2	0.01	195	8.6	0.01	....
	1956	4.0	497	8.3	0.02	443	8.5	0.02	....
Montgomery Co., Md. (B)	1952	0.0	237	13.8	0.06	233	13.9	0.04	+ 0.02
	1953	1.0	250	13.9	0.19	230	13.6	0.16	+ 0.03
	1954	2.0	233	13.7	0.10	244	13.7	0.08	+ 0.02
	1955	3.0	221	13.4	0.04	186	13.5	0.04	....
	1956	4.0	176	13.5	0.05	197	13.5	0.06	− 0.01
Prince Georges Co., Md. (C)	1952	0.1	874	9.1	0.03	435	8.9	0.02	+ 0.01
	1956	4.1	778	8.8	0.03	680	8.9	0.02	+ 0.01
Prince Georges Co., Md. (D)	1952	0.1	303	13.9	0.06	171	13.8	0.04	+ 0.02
	1953	1.1	201	14.0	0.21	161	14.1	0.17	+ 0.04
	1954	2.1	238	13.6	0.05	198	13.7	0.07	− 0.02
	1955	3.1	322	13.6	0.08	306	13.6	0.06	+ 0.02
	1956	4.1	499	13.6	0.11	414	13.7	0.08	+ 0.03
Prince Georges Co., Md. (E)	1953	1.2	449	14.0	0.36	173	14.1	0.29	+ 0.07
	1954	2.2	441	13.9	0.26	191	13.9	0.26	....
	1955	3.2	315	14.1	0.24	143	14.2	0.19	+ 0.05
	1956	4.2	423	13.9	0.18	191	13.9	0.18	....
Muskegon, Mich. (F)	1952	1.3	147	15.5	0.06	95	15.4	0.11	− 0.05
	1953	2.3	158	14.1	0.17	96	14.7	0.14	+ 0.03
	1954	3.3	155	15.1	0.04	106	15.8	0.05	− 0.01
Prince Georges Co., Md. (G)	1954	2.3	495	16.9	0.30	258	16.9	0.26	+ 0.04
Muskegon, Mich. (H)	1955	4.3	645	9.5	0.04	205	10.3	0.08	− 0.04 *
Grand Rapids, Mich. white (I)	1952	7.8	288	14.4	0.07	147	14.8	0.05	+ 0.02
	1953	8.8	296	13.7	0.10	139	14.2	0.13	− 0.03
	1954	9.8	595	14.5	0.05	431	14.7	0.06	− 0.01
	1955	10.8	627	14.4	0.07	501	14.7	0.09	− 0.02
Grand Rapids, Mich. Negro (J)	1952–1955	8–11	110	14.6	0.14	279	14.8	0.11	+ 0.03
Aurora, Ill. (K)	1953	13.5	360	13.5	0.09	207	13.5	0.11	− 0.02

* Difference significant at the P = 0.01 level.

verse effect is evident is wholly incompatible with any hypothesis that use of a fluoride-bearing domestic water is harmful to the periodontal tissues of children or of adults.

On the other hand, the slight differences in favor of the fluoride communities are too weak for acceptance as evidence that use of a fluoride water is beneficial to periodontal tissues. With the exception of Boulder the findings for these groups are very similar in all details to those for the total population of white urban residents so far examined.[1] In this total population most of the other persons aged 20 years or older were residents of Baltimore, using a fluoride-free water at the time of examination.

Natives Versus Migrants in Fluoride Communities

Marked differences in caries inhibition have been demonstrated by within-group analyses of residents of fluoride areas. Those children who had used the fluoride water since birth have shown significantly lower caries scores than those children who had moved into the community at some time after birth and had, hence, used the same water for a shorter period of time.[11] Accordingly, a similar analysis was applied to the periodontal data gathered by us in such communities. The examinations of about 18,000 children in communities with domestic water supplies that had contained about 1.0 ppm of fluorides for varying lengths of time are summarized in Table 4.

If use of a fluoride domestic water is actually harmful to periodontal tissues, the data of Table 4 should reveal a trend opposite in direction to that seen in the inhibition of dental caries, i.e., the longer the fluoride water has been in use by natives, the more migrant children should excel native children in periodontal health. When the duration

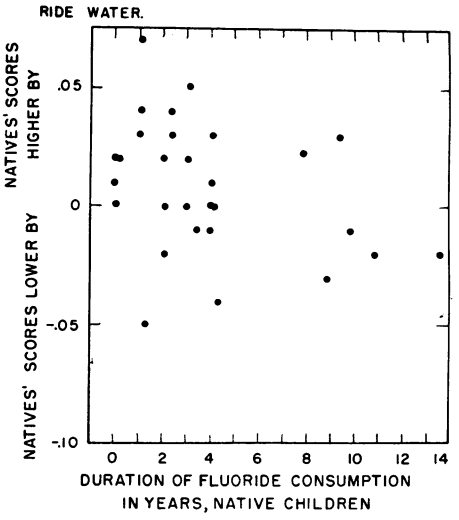

Figure 1—Relation Between Absolute Differences in Periodontal Scores, Native and Migrant Children in Fluoride Communities, and the Number of Years Native Children Had Consumed a Fluoride Water.

of fluoride consumption by natives is plotted against the difference in scores * between native and migrant children the result is as shown in Figure 1.

Simple inspection of this figure shows that no adverse trend, i.e., a worsening of the relative periodontal status of native children related to the length of time they have consumed a fluoride-bearing domestic water, is apparent. On analysis there is a weak but definite negative correlation indicating that, in general, the greater their advantage in the consumption of water-borne fluoride, the more native children tend to excel

* In this array periodontal scores are generally elevated for a group examined coincident with the peak, or early on the declining slope, of an outbreak of an upper respiratory infection, sometimes influenza A or B (reference 1). This was generally the case in the schools examined in 1953, and was observed sporadically in other years. Comparisons between total scores are misleading unless corrections for this factor are made. But differences between scores within groups are virtually independent of this factor, since the outbreaks tend to affect native and migrant children to an equivalent degree.

migrant children in the health of their periodontal tissues.

As in the fluoride-nonfluoride contrasts, this finding cannot be accepted as evidence that use of a fluoride domestic water enhances the health of periodontal tissues. The difference between a random pattern and that shown in Figure 1 is not great. But the finding is clearly incompatible with any hypothesis that use of a fluoride domestic water is injurious to periodontal health.

This result cannot be ascribed to examiner bias, since the residence history of none of the children was known to the observer at the time of examination.

Summary and Conclusions

The periodontal status of residents of three fluoride communities has been compared with the periodontal status of residents of three comparable low- or nonfluoride communities. Ages of the persons studied ranged from seven to 78 years. The domestic water supplies of the fluoride communities carried about 1.0, about 2.5, and about 8.0 ppm of fluorides, respectively. Fluoride subjects had used the domestic water for from seven to 44 years. Indirect evidence in the two adult groups was opposite in direction. In each case the fluoride group exhibited the more favorable periodontal condition on direct examination.

Native school children in a series of communities, each with about 1.0 ppm of fluorides in its domestic water, were compared with migrant children in the same communities. There was a weak tendency for the periodontal health of native children to improve, relative to that of migrants, as their advantage in water-borne fluoride consumption increased.

Most of the differences were slight. They are not adequate to support a hypothesis that use of a fluoride water results in improved health of periodontal tissues. The findings are, however, wholly incompatible with any hypothesis that the periodontal tissues of children or of adults are harmed by use of a fluoride-bearing domestic water.

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